THE SURVIVAL OF PATHOGENIC BACTERIA AND OTHER MICRO-ORGANISMS IN FRUIT JUICES

BY

JOHN CLIFTON AYRES

B.Ed., Illinois State Normal University, 1936

M.S., University of Illinois, 1938

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
BACTERIOLOGY IN THE GRADUATE SCHOOL
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I. Introduction

Although numerous outbreaks of diseases due to organisms in or on fruits have been reported, an attitude of unconcern regarding proper sanitary precautions in the handling or storage of juices still prevails. This investigation has been undertaken in order to determine how bactericidal some of the more common fruit juices are to typical intestinal pathogens.

II. Review of Literature

A resumé of the more pertinent findings is presented covering each of the following topics: Pathogenic bacteria and other micro-organisms found on fruits, survival of pathogenic bacteria and other micro-organisms inoculated in or on fruits, effect of temperature on bacteria, survival of bacteria and yeasts frozen in fruit and in fruit juices, effect of hydrogen ion concentration and titratable acidity on micro-organisms.

III. Experimental

A standard technique was attempted. Fresh fruits and canned fruit juices were purchased on the open market. After soaking the uncut fruit in a 1:1000 mercuric chloride solution and thoroughly washing with sterile water, the juice was expressed aseptically by means of a sterile pliers-type juice extractor placed between two sterile large culture dishes. Cans containing juices were wrapped with a towel soaked in mercuric chloride solution and by means of a sterilized special type vacuum gauge the amount of evacuation was determined. Following this, the can was opened aseptically. Both canned and fresh juices were transferred to dilution bottles which were, in turn, inoculated with pure cultures of the more important aerobic non-sporing pathogens of the gastro-intestinal tract or with a pure culture of a bacterial indicator of pollution. After shaking, the juice plus bacteria was transferred by means of a sterile syringe to sterile two ml vaccine ampoules and stored at room temperature or in refrigerators in the frozen state. At regular intervals quantitative samplings were made and plated on dextrose-tryptone agar.

Counts were obtained and recorded. Total acidity and pH readings were taken. Tables are given for every organism in each juice and rates of survival for representative cultures are compared by semi-logarithmic graphs.

IV. Discussion

The various juices tested were compared according to their lethal action on the bacteria used. Causes for variations in results were also discussed.

V. Conclusions

The assumption that bactericidal action of fruits renders them innocuous after short storage periods, either at room temperature or in the frozen state, is dependent upon a number of factors including the contaminative load, the species and strain of organism entering the fluid, and the degree of temperature at which the juice is preserved.

Some juices are more germicidal than others. Lemon and lime juices were highly bactericidal and were able to destroy most bacteria within a very few minutes after inoculation. Apricot nectar and pineapple and tomato juice were the least severe in their action on pathogenic organisms. *Aerobacter aerogenes* and *Escherichia coli* found the latter two juices favorable for preservation and even reproduction.

In some of the fruit juices, the added effect of freezing was harder on bacterial cells than was the action of fruit acid at room temperature.

Effects of freezing were variable. In lemon, lime, and grapefruit juice, freezing did not increase longevity since the fluid was so highly toxic that few cells were viable by the time that crystallization had become noticeable. In grape juice, apple juice, and cherry juice survival rates in frozen juices as compared to fluids stored at room temperature varied with the organism. In many cases longevity was more prolonged at the lower temperature.

Organisms stored in cherry juice and held at —16°C (3.2°F) and —8°C (17.6°F) remained viable for a longer period at the lower temperature.

Ten per cent sucrose diluting fluid was not shown to be a more favorable diluting medium than distilled water. Calcium carbonate

added to water used in diluting high acid samples allowed more abundant growth upon subculture.

Staphylococcus aureus was usually more resistant to fruit juices than any of the other pathogenic forms. *Salmonella paratyphi* did not persist as long as other members of the genus. *Eberthella typhosa* remained viable for a longer period than *Salmonella paratyphi* but not as long as *Salmonella schottmuelleri.*

While storage of the high acid lemon and lime juices at either room temperature or in the frozen state is comparatively safe, apricot and pineapple juice may harbor dangerous organisms for weeks. Tomato juice, subjected to contamination by intestinal pathogens, should not be used without employing some means of sterilization.

If juice is frozen, it is advisable to store the material at a point immediately below the limit of crystallization rather than at a lower temperature.

VITA

John Clifton Ayres was born April 17, 1913, at Beckemeyer, Illinois. He graduated from Carlyle High School May, 1931. While in his senior year, he passed the Illinois State Teacher's Examinations and began teaching the Bethel rural school in the fall of 1931. Three years were spent at this vocation. During summer vacation between school terms he studied at Illinois State Normal University, Normal, and at Southern Illinois Normal University, Carbondale. Following the close of the school year 1933-1934, he resigned his teaching position in order to work toward the degree of Bachelor of Education. This degree was earned at Illinois State Normal University in August, 1936.

The following month he was employed to teach biology, mathematics, and visual education classes at Normal Community High School, Normal. He taught there for five years. At the same time, he attended the University of Illinois on Saturdays and during summer sessions. In August, 1938, he received the degree of Master of Science in Bacteriology. In the year 1941-1942 he was given a leave of absence from the staff at Normal Community High School to attend the University of Illinois, the recipient of an University Fellowship.

The author has been granted an Illinois Life State Teachers' Certificate. He is now chairman of exhibits of the Illinois Junior Academy of Science. He is a member of Kappa Phi Kappa, Kappa Mu Epsilon, Phi Sigma, and an active member of Sigma Xi.

Publications include: Vitamin studies, The Science Teacher 5, 2, (1938); The history of tobacco downy mildew in the United States in relation to weather conditions, Phytopathology 30, 684-688 (1940); The Illinois State Junior Academy of Science, the Science Teacher 8, 1 (1941).

He has recently been appointed Bacteriologist on the Research Staff of the Wm. S. Merrell Company, Cincinnati, Ohio.

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